INSECTS ATTACKING GROUND CHERRY (*Physalis* Spp.) Solanaceae

by

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INTRODUCTION

This study was begun to determine the interrelationship of the species of insects attacking ground cherry plants belonging both to the wild and cultivated species. It was necessary to limit the study to those species growing wild in the vicinity of Manhattan, Riley County, Kansas. The work was started late in June, 1946, and was concluded in September, 1947.

The reasons for studying this problem are:

1. Ground cherry is closely related botanically to several cultivated garden plants, namely, potato, tomato, peppers, mango, garden huckleberry, tobacco, and husk tomato.
2. Some Solanum diseases may carry over the winter on ground cherry and be transmitted to related cultivated plants by insects feeding on ground cherry.
3. To ascertain the species of insects associated with the various species of Physalis.

So far as is known, this paper is the first attempt at compiling a list of insect pests of the Genus Physalis. The list of species has been divided into two parts, one, a list of species compiled from the literature, and the other is a list of those insects which have been collected on ground cherry plants in the field by the writer.

REVIEW OF THE LITERATURE

Ballard (1924) states that Heliothis obsoleta Fabr. prefers maize as food, but it will attack cotton and does feed on plants of the Genus Physalia. Ballard (1927) says, "Heliothis obsoleta Fabr. was found on Cape Gooseberry-----near Rabaul." He also says that this insect is suspected of causing damage on plantations. Ghosh (1940) records H. obsoleta Fabr. as having the following life cycle on gram pod (chick peas): egg - four days, larva - two to three weeks, and pupa - one week.

Doolittle, Walker, Gardner, Kendrick, Patch, and Allard are of the opinion that mosaic of cucumbers and tobacco overwinters in the roots of plants of the Genus Physalis. Doolittle (1924) asserts that it is known that the mosaic disease of cucumbers overwinters in the roots of ground cherry. Walker (1925) writes that the mosaic of Physalis pubescens L. is readily transmitted to cucumbers by Aphis gossypii Glover. "It has been found that a mosaic disease lives overwinter in two perrenial species of Physalis, Physalis subglabrata M. and B., and Physalis heterophylla Nees." Walker also found that the mosaic disease is readily communicated to the cucumber by the cucumber aphis and by artifical innoculation, and is also transmissable to Physalis pubescens L.

Gardner and Kendrick (1922) found that in the early spring before cucumbers are available, ground cherry serves as an important host of Aphis gossypii Glover, and Acalymma vittata

(Fabr.)[1] which transmit the mosaic from the ground cherry to cucumbers. "It has been proved that the mosaic virus persists overwinter in the rootstalks of Physalis subglabrata M. and B. The young mosaic shoots appear in the spring before tomatoes are transplanted to the field. From these shoots the disease has been transmitted to tomatoes." Gardner and Kendrick say that the preceding statements are true only when ground cherry plants are growing in or near fields once used for tomatoes or cucumbers.

Allard (1912) states that mosaic was once thought to be physiological in origin, but there was no difficulty in transferring the tobacco mosaic from tobacco to Physalis Spp. He also states that there is evidence of the disease in wild plants and from observations, there appears to be a relationship between the disease and aphid infestations. Allard found that the mosaic of pokeweed, tobacco and tomato apparently is transmitted by aphids and is known to overwinter in Physalis subglabrata M. and B., and Physalis heterophylla Nees.

Byars (1920) found that the nematode, Tylenchus dipsaci Kuhn, which spreads a disease of red clover and strawberries is also found on ground cherry. "The writer (Byars) has found the nematode attacking only one wild plant, Physalis Sp., which was growing in a badly diseased field of clover in Utah."

Plants of the Genus Physalis harbor several other insect pests, many of which feed on ground cherry as either a primary

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[1] Barber, H. S. Diabrotica and two new Genera (Coleop. Chrysomelidae) Proc. Ent. Soc. Wash. 9(6):151-161, June, 1947.

or a secondary food plant.

Glick (1922) learned that Deloyala clavata (Fabr.) is a serious pest of vegetables and chillies (cayenne or red pepper). He found that the natural food plant of this insect in Arizona is ground cherry Spp. Jarvis (1924) found fruit flies ovipositing on ground cherry during the month of March in Australia. Misra (1929) observed that the cotton white fly, Bemisia gossypiperda Misra, breeds in large numbers on Physalis peruviana Linn in India.

Patterson (1914) states that Helopeltis bergrothi Misra, a serious pest of cacao pods along the Gold Coast, is able to live at least seven days on Physalis Spp. Morgan (1924) states that the preferred food of Epitrix parvula Fabr. is ground cherry. Patch (1923) says that the secondary food plants of Macrosiphum solanifolii Ash are ground cherry. Macrosiphum solanifolii Ash is also a serious pest of spinach. According to Tryon (1923), plants of the Genus Physalis are the best alternate food of Chloridea obsoleta Fabr. which is a pest of cotton and tomatoes.

Hoffman (1927) states that in China, Acanthocoris scabrator F. is a serious pest in Physalis peruviana Linn or cape gooseberry. Hoffman (1932) found that two lygaeids, Lygus hospes F. and Aphanus sordidus Fabr. are also pests in cape gooseberry. Newman (1928) in Australia found the larva of Phthorimaea operculella Z. boring into the stems of plants of cape gooseberry causing dying back.

Chamberlain (1926) found the tobacco budworm, Heliothis

virescens Fabr. feeding to a slight extent on Physalis viscosa L., but states that it appears unable to mature on this plant. Marcovitch (1916) observed Lema trilineata (Oliv.), a pest of cucumbers and potatoes, ovipositing on ground cherry in June. He believes that there are two broods a year on ground cherry.

Hutson (1918) says that in St. Vincent, Phthia picta Drury, the red tomato bug, while not a serious pest, is capable of puncturing cotton bolls and infecting them with internal boll diseases. Phthia picta Drury is found normally on Physalis Spp. in St. Vincent. Morrill (1914) found larvae of Estigmene acraea Drury attacking Physalis angulata L. in Arizona.

Steiner (1935) found Aphelenchioides hunti Steiner as a parasite in Physalis ixocarpa Brotero, the tomatillo (husk tomato), coming from Mexico. Romshe (1942) learned through field tests that the husk tomato, Physalis pubescens L., is quite resistant to heavy infestations of the nematode, Heterodera marioni Cornu.

Holmes (1942) observed tobacco etch virus on ground cherry. Valleau and Johnson (1936) stated that Physalis subglabrata M. and B. is a natural host of Bacterium angulatum. They report that plants collected from fence rows and fence corners two months after tobacco harvest produced an infectious strain.

Patch (1921) lists four species of ground cherry, Physalis pruinosa L., Physalis subglabrata M. and B., Physalis virginiana Mill., and Physalis viscosa L. as secondary food plants of the aphid, Macrosiphum solanifolii. Gould (1930) also lists Physalis virginiana Mill. as an alternate food plant for Myzus

persicae (Sulzer). Walker (1925) found that the mosaic of Physalis pubescens L. is readily transmitted to cucumbers by Aphis gossypii Glover.

Faville and Parrott (1899) report Tricobaris trinotata (Say) as occurring in the stems of ground cherry, Physalis longifolia Nutt. "In several of the weeds, particularly in the ground cherry, the insect is more numerous than in potato." Metcalf and Flint (1939) mention Tricobaris trinotata (Say) as attacking potatoes and related species, including ground cherry.

Ground cherry usually is classed as a weed in most botanical manuals. The New Standard Dictionary gives this definition of a weed: "Any unsightly or troublesome plant that is at the same time useless-----especially a plant that is noxious or injurious to crops." Chamber's Technical Dictionary gives this definition: "A plant growing where it is not wanted by man, a potato growing in a bed of geraniums would be a weed."

MATERIALS AND METHODS

Generic Description.[2] Ground cherry plants belong to Solanaceae, the nightshade family, and to the Genus Physalis. The following is a description of the Genus.

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[2] This generic description, key to species included in this study, and the descriptions of species have all been adapted from:
Gray's New Manual of Botany, 7th. ed. 714-715.
Rydberg, Pa. Flora of the Prairies and Plain of Cent. N. Am. 1932. 698-702.

Annual or perennial herbs, leaves alternate, entire or sinuate toothed, without stipules. Flowers perfect and regular. Calyx campanulate, five lobed, accrescent and becoming bladder-like in fruit, five angled or prominently ten ribbed. Corolla hypogynous, limb mostly lobed, yellow or whitish often with a darker brownish or purplish center, plicate in the bud. Stamens five, filaments adnate to the base of the corolla, anther sacs opening by longitudinal slits. Gynoecium of two united carpels, style terminal, stigma minute and entire. Seeds numerous, kidney shaped, flattened, finely pitted.

Key to Species. Although various authors list 15 to 17 species of ground cherry, only seven have been included in this study. The following is a key to the seven species used. This key is adapted from the complete key by Rydberg.

1. Leaves and stem glabrous, or crossveins of former and upper part of latter with scattered appressed hairs 2
    2. Fruiting calyx ovoid nearly filled with the berry, scarcely sunken at the base..... 3
        3. Leaves ovate, ovate lanceolate or oval..P. subglabrata
        3. Leaves lanceolate, oblanceolate or linear..P. longifolia
    2. Fruiting calyx pyramidal, much inflated and deeply sunken at the base.....P. macrophysa
1. Leaves and stem more or less covered with spreading hairs 4

4. Pubescence sparse, consisting of flat, sometimes spreading jointed hairs, scarcely viscid 5

5. Fruiting calyx ovoid, scarcely angled and scarcely sunken at base. Leaves thick, often rhombic, hairs on lower surface branched .... P. pumila

5. Fruiting calyx pyramidal-ovoid, obtusely 5 angled and deeply sunken at base. Leaves ovate to lanceolate, generally more or less toothed .... P. virginiana

4. Pubescence dense, viscid, partly of fine and short, partly of long, flat, jointed hairs 6

6. Plants erect and ascending .. P. comata

6. Plants prostrate and diffuse .... P. rotundata

These species may be described briefly and distribution noted as follows.

P. subglabrata Mack and Bush. Stem 3-9 dm. high, leaf blades 3-7 dm. long, entire or undulate, glabrous or very sparingly strigose. Calyx strigose, in fruit ovoid reticulate, 2.5-3 cm. long. Corolla yellow with darker center, 1-1.5 cm. broad. Leaves ovate or ovate oblong, oblique at base. At maturity, calyx filled by the large

EXPLANATION OF PLATE I

Perennial ground cherry.

A. Mature fruit, showing inflated calyx.

B. Above ground portion of the plant.

C. Seed of ground cherry.

D. Root system of perennial ground cherry.

PLATE I

reddish or purple berry and open at the mouth. Cultivated or sandy soil, Pa. to Colo. and Idaho.

P. longifolia Nutt. Stem tall, 5-10 dm. high, leaf blades entire-margined or somewhat repand, calyx glabrous or nearly so, in fruit ovoid, about 3 cm. long. Corolla 1-2 cm. broad, yellow with brownish center, berry yellow, lower portion and stipe glutinous. Plant essentially smooth, green, and much branched above. Rich soil, Iowa and southwestward.

P. macrophysa Rydb. Stem 5-10 dm. high, glabrous, leaf blades thin, 4-8 cm. long, the lower obtuse, the upper acute or acuminate, slender petioled, peduncles reflexed at maturity. Calyx teeth ovate, triangular, corolla yellow with a dark center, 2 cm. broad. Fruiting calyx 3-4 cm. long, indistinctly ten angled, berry small, in center of inflated calyx. Rich soil, Ark., Kans. to Texas.

P. pumila Nutt. Stem 3-10 dm. high, obscurely angled, hirsute. Leaf blades thick, acute at both ends, 5-10 cm. long, entire or toothed-sinuate. Calyx densely hirsute, 4-5 cm. long, corolla yellow with brown center, 1.5-2 cm. broad. Stems geniculate, shortly hirsute with spreading once or twice branched, sordid hairs. Prairies and river valleys Ill. and westward.

P. virginiana Mill. Stem 3-10 dm. high, erect, angular, more or less hirsute, leaf blades 3-6 cm. long, hirsutious. Calyx hirsute or puberulent, corolla 1.5-2.5 cm. broad, sulphur-yellow with purplish center, berry reddish. Leaves

narrowly ovate, mostly acutish at both ends. Prairies, river valleys and cultivated ground, New York to Texas.

P. comata Rydb. Stem about 5 dm. high, finely short-pubescent and viscid with a few scattered long hairs on the upper part. Leaf blades 3-5 cm. long, somewhat repand or entire, finely pubescent. Calyx finely pubescent and villous, in fruit 3-4 cm. long, rounded-ovoid, scarcely sunken at the base. Corolla yellowish-green with brownish center. Hillsides, cliffs and dry plains, Neb. and south to Texas.

P. rotundata Rydb. Stem diffuse or spreading, dichotomously zig-zag branched, densely and finely viscid pubescent. Leaf blades with truncate or subcordate base, 2-4 cm. broad, sinuate-dentate. Fruiting calyx ovoid, scarcely angled, not sunken at the base. Corolla 1.5 cm. broad, greenish-yellow, with brownish center. Plains, S. D. and southwestward and southeastward.

Ground cherry plants are very hardy, and apparently are able to withstand adverse conditions such as infertile soil and long periods of dry weather. The species included in this study have been found in abundance along uncleaned fence rows as well as in cultivated fields. Physalis macrophysa Rydb. and Physalis virginiana Mill. have been observed in small areas in old cow pastures. If given the opportunity, these species spread from the fence rows to cultivated fields where they soon become a pest. Some ground cherry plants were able to withstand at least one cutting back to ground level, and probably two. In

one instance, ground cherry plants were found coming through the surface in a field that had been plowed only two weeks before.

Physalis comata Rydb. and Physalis rotundata Rydb. were found growing along a sandy road where rock formations were showing through the sand. P. comata Rydb. was also found growing on top of a hill where limestone was showing through the surface. The other three species included in this study, P. subglabrata Mack and Bush, P. longifolia Nutt., and P. pumila Nutt. were not found in abundance, but appeared frequently in fence rows, old abandoned gardens and pastures.

Ground Cherry Habitats. In doing the field work for this problem, ground cherry plants were observed in many types of environments. However, during the summer of 1947, there was an opportunity to record several definite locations of ground cherry areas, and the following is a description of these areas together with the species of ground cherries associated with each.

Area 1: On the Agronomy Farm, Kansas State College, Manhattan, Kansas. The plants were growing in an oats field and along the margins of the field. The oats were in full head, but it was a thin stand with ground cherry plants crowding out oat plants. The plants which were growing along the sides of the field were among grass plants. The grass had been cut about the third week in May, and the ground cherry had sent up new stems and made fruit in six weeks. These plants

were much shorter and bore less fruit than those in the oats field. The species of ground cherry was Physalis subglabrata M. and B.

Area 2: On top of Bluemont Hill, Manhattan, Kansas. Most of the plants were among underbrush consisting largely of Rhus glabra L., smooth sumac. Several of the plants were in tall grass, Andropogon furcatus Muhl, big blue stem. There was little top soil in the area. In most places, the rock strata were only a few inches beneath the surface. The species of ground cherry found here were Physalis subglabrata M. and B. and Physalis virginiana Mill.

Area 3: This area was located about two miles south of Manhattan, Kansas, along State Highway 13. The area was divided into two distinct parts. The first part was typical roadside, no real top soil and frequent outcropping of rock. The species in this part were Physalis comata Rydb. and Physalis rotundata Rydb. The second part had once been a cultivated field but was now overgrown with weeds. The species in this part was Physalis virginiana Mill.

Area 4: At the southeast corner of the cemetery along Sunset Ave., Manhattan, Kansas. In this small area, five plants were located growing in the middle of a wild grape vine which was trailing on the ground. Most of the plants rose above the vine, but some plants were found covered by the vine. The soil in this area was

fertile and deep. The species was Physalis virginiana Mill.

Area 5: About 100 yards west of Van Zile Hall at the north edge of the campus of Kansas State College. The plants were on the north side of the east-west road. The area was poorly tended, grown over with elderberry bushes and tall grass interspersed with ground cherry plants. The species was Physalis virginiana Mill. The soil in this area was of the sandy loam type.

Area 6: Along the west side of the north-south road at the east side of the Poultry Farm, Kansas State College. The plants were growing on a rather steep slope facing south. The soil was thin and very rocky. The plants were growing in among elderberry bushes and other weeds. The species were Physalis subglabrata M. and B. and Physalis virginiana Mill.

Area 7: Along the south side of the main building at insectary No. 1, Kansas State College. The plants were growing just a few inches from the side of the building. The area was well kept and watered frequently. There were only four plants at this location, but due to the frequent watering the plants had reached their maximum growth of about three feet. The species was Physalis subglabrata M. and B.

Area 8: An old, unused garden and strawberry patch beyond field insectary No. 1, Kansas State College. The plants were growing among tall grass and prickly lettuce.

None of the plants was tall enough to show above the tall grass. The area was well shaded by several tall trees. This area was not cut over during the summer of 1947. The species was predominantly Physalis virginiana Mill. but several plants of Physalis subglabrata M. and B. were also present.

Area 9: Along the sides of the east-west lane between the Poultry and Dairy Farms, Kansas State College. Most of the plants were growing in the fence row. Other plants were growing in the same area, away from the fence row, but these had been cut back at least once with a mowing machine and bore no fruit. The soil was of the sandy loam type. The species were Physalis longifolia Nutt. and Physalis virginiana Mill.

Area 10: Along the first road to the left, north of the dairy barn at Kansas State College. Some of the plants were growing in the ditch beside corn fields, others at the edge of a kafir corn field, and still others were growing along the margins of an alfalfa field. None of these plants was in the fields themselves. Many of the plants had been cut back at least once by a mowing machine, but had fully recovered and were bearing fruit. These plants growing in the ditches were subject to extensive washing during each rain. These plants had never been cut off and had reached their maximum growth. The species was Physalis virginiana Mill.

Area 11: Along State Highway 13, about four miles north of Manhattan, Kansas, near the Casement ranch. The plants were growing in an old unused cow pasture which was overgrown with Canada thistle, snow-on-the-mountain, tall grass and briars. None of the ground cherry plants was visible above these weeds. The soil was fertile, deep and well fertilized due to the previous pasturing of cattle. The species was Physalis virginiana Mill.

Area 12: At the northern end of the Agronomy Farm, Kansas State College. The plants were growing along what is now a drainage ditch. The grass and weeds were not tall in this area, and the ground cherry plants were numerous and formed small areas to the exclusion of other plants. This area, prior to the Pleistocene Age, was the channel of the Kansas River. The species were Physalis virginiana Mill. and Physalis longifolia Nutt.

Rearing Methods. In the beginning, plants were brought in from the field and transplanted to the insectary field. Plants were also brought in from the field and placed in six-inch flower pots in order that they could be cared for more easily. All of the plants were young when transplanted. In the summer of 1946, specimens of Physalis subglabrata M. and B. were brought in to the laboratory. These plants died back slightly with no apparent permanent injury after living for several days. They recovered rapidly, however, and although they were not set out in the field, they were used in rearing studies.

In the summer of 1947, specimens of Physalis rotundata

Rydb. were transplanted to the six-inch flower pots. After several days of apparently normal growth, the plants began to die back, and, in this case, died back to the roots. It was thought that the plants were dead, so rearings in 1947 were abandoned. The plants were not in the way, and through an oversight, were untouched for almost two months. At this time, the pots were cleaned up and it was found that the roots were alive and sending out shoots.

When the rearings were begun, the plants were small enough so that it was possible to use a medium sized cone of fine mesh screen wire as a cage. The plants were left in the six-inch flower pots, insects to be reared were placed on the plants and the cage placed over the plant. The cages were just large enough to touch the side of the flower pot all the way around. Thus, the insects had sufficient room to move around on the soil in the pots. It also provided the medium for those larvae which normally pupate in the soil.

The potted plants were examined daily, and the activities of the insects placed upon them observed. In this manner, the life history of one insect Lema trilineata (Oliv.) was recorded. This record is for ground cherry, Physalis subglabrata M. and B. only, and it cannot be assumed that the results would be the same for a plant of another genus or even for another species of Physalis.

Rearings from Pods. Ground cherry plants were examined and collections were made of damaged fruit in an attempt to rear out insects from the fruit itself. Several hundred berries,

all of which showed obvious damage, were collected and brought into the laboratory. The damaged pods were placed in small, seamless, one-ounce salve boxes which were closed with the regular cover. No soil was placed in the boxes because it was found that the insects feeding in the berries were pupating in the fruit when the insects were mature. The boxes were opened each day during the morning, and insects which had emerged during the night were removed and placed in the ground cherry insect collection.

Larvae which were collected feeding under the husk and eating the berry were placed in a larger salve box, and soil was placed in the boxes. The larvae in these instances were considerably larger than any encountered previously, and were capable of consuming at least one complete fruit, berry and husk, in a single day. Since they did eat a great deal of food, the boxes in which they were kept were reopened each day and the remnants of the old fruit were removed and replaced with a fresh pod. All the larvae in these instances did pupate in the soil provided for them. The soil was only about one inch deep, and the pupal cases usually were at the bottom of the box, so it is not known at what depth they would pupate if they could go down to an unrestricted depth.

Field Work. Daily trips were taken to collect as many insects from ground cherry as possible. From the middle of June till the first week of September, certain plants were visited each day, and others were visited every two days. No attempt was made to count the number of plants visited each

day. Of the total number of plants visited daily, only a few were examined closely. The time involved made it impossible to spend more than one or two minutes with most plants, and two or three minutes with a few plants. There was no effort made to visit the plants in definite sequence. Many of the plants were along a road, and at times, one end of the road would be the starting point, and at other times, the opposite end would be the starting point. Here, the plants were examined at various times of the day. Some days the plants were visited early in the morning, sometimes during the middle of the day, and several times it was done during the early evening. It was hoped that a greater number of species of insects would be taken due to their appearance at different times of the day.

During the summer of 1946, all the studies were made on or near the insectary grounds, with but one exception. On several occasions transportation was provided to the Agronomy Farm at Kansas State College. On these trips, two areas were studied. One area was located along the edge of a soybean field, and the other was in an old, unused pasture. No sweeping was done during these studies.

During the summer of 1947, somewhat different methods were used for collecting insects from ground cherry. Due to a change in farming, the areas visited during 1946 were of no value for collecting in the summer of 1947. Several fields of ground cherry were located, and during the course of the summer, these fields were visited at every opportunity. On such trips, adult insects were collected when found, larvae were brought

back when taken, and pods were collected as during the first summer for rearing purposes.

Pod Examination. During late August and early September of 1947, investigations to ascertain the percentage of damage to the berries were started. Since this examination was to concern the berries, none was picked unless it had an approximate diameter of one-fourth inch or more. In order to carry out this investigation, large numbers were desired. On all locality examinations, at least 100 pods were the goal. Only once was the number of pods collected at a given locality short of this number. All the fruits meeting the requirements earlier were removed from each plant in the area. In order that the examination be accurate, all fruit meeting the requirements on each plant was taken. No attempt was made to limit the number of pods collected to a certain number except that at least 100 pods were desired. The pods were brought to the laboratory for examination. In the laboratory, the fruits were classed under two main categories: 1. Fruit with husk damaged. 2. Fruit with husk undamaged. Under each of these two main headings were two lesser categories, berry damaged, and berry undamaged. By using these categories, it was possible to determine:

1. The percentage of damaged berries.
2. Whether damage to the berry could be detected by merely examining the husk.
3. The percentage of husk damage.

The berries were split open with a razor blade in order that

damage to the inside of the berry could be seen.

Sweeping. During the first two weeks of September, 1947, ground cherry plants were swept with a regular sweep net in order that insects not otherwise noticable could be obtained. In all areas swept, the ground cherry plants were the predominant plants rising above the grass and weeds. By using areas such as this, it was hoped that the possibilities of taking insects not on ground cherry would be minimized. Since it was desired to collect as many insects as possible, no set numbers of sweeps with the net were employed. An attempt was made to contact all the plants in each area swept.

Stem Inspection. In early October, ground cherry plants were examined for the presence of stem borers. Most of the areas in which the extensive collecting had been done during the summer were cut over with a mowing machine. The chief areas still available for stem borer examination were along roadsides on the Agronomy Farm. At first a knife was used to dig around the root of the plant to a depth of about four inches, and then the root was cut off at this point. A borer was found in the stem of ground cherry and a study of the literature and actual specimens showed that a high percentage of insects would be taken merely by grasping the plant firmly about six inches above the ground level and pulling it out. Even though the insect itself was not obtained, in every instance, enough of the root would be present so that borer infestation could be tabulated. All plants available were pulled up in each area studied, and a record was kept including the total numbers

of plants examined and the number affected by the stem borer. Photographs were obtained both of the larva and adult of this stem borer, showing, in the case of the larva, its position in the stem.

PRESENTATION AND DISCUSSION OF DATA

Species Encountered. One of the most important things which had to be done early was to determine the species of ground cherry to be included in the study. According to "Gray's New Manual of Botany," Seventh Edition, there are 15 species of ground cherry in the central and northeastern United States. Britton and Brown in "An Illustrated Flora," Vol. III, 1913, listed 17 species, but indicate that the World Genus contains about 75 species, 30 of which are likely to be found in the United States. Nine species are mentioned by Dr. Frank C. Gates in the State Board of Agriculture publication, "Weeds in Kansas." Of the nine species of Physalis mentioned by Dr. Gates, who is a plant taxonomist at Kansas State College, six have been collected in the fields where pods were taken or where insects were collected. The following are the species that have been identified from local areas: Physalis rotundata Rydb. ground cherry, Physalis pumila Nutt. low ground cherry, Physalis virginiana Mill. ground cherry, Physalis subglabrata Mack and Bush smooth ground cherry, Physalis longifolia Rydb. ground cherry, and Physalis comata Rydb. Physalis macroptysa Rydb. was identified, but was not found often enough to be

included in this study. It, however, has been included in the key since it was found, and also to fill out the key.

Rearing Records for Lema trilineata (Oliv.). During the latter part of June and the first part of July, 1946, larvae resembling that of the Colorado potato beetle, except for color and size, were quite common on Physalis subglabrata M. and B. around the garden at the field laboratory. These larvae were pale yellow in color with a black head, and entirely devoid of hairs. They were smaller than the larvae of the Colorado potato beetle. One of the identifying characteristics of this larva was its habit of carrying large amounts of its own excrement on its back. Thirty of the larvae were collected from the plants, taken inside and placed on the potted plants to be reared to adulthood. The plants in the pots were Physalis subglabrata M. and B., and an identification of the adult insects showed them to be Lema trilineata (Oliv.).

The larvae were collected on July 12, 1946. They pupated on July 14, and the adults emerged on July 25. Both in the laboratory and in the field, the larvae were observed to be voracious feeders. If left unmolested on a small plant, 15 or 20 larvae would defoliate the plant within a few hours. The adults are also leaf feeders, and have been observed feeding on the leaves of Physalis subglabrata M. and B., Physalis virginiana Mill. and Physalis longifolia Nutt. in the field.

The larvae of Lema trilineata (Oliv.) appeared almost fully grown due to their size, when collected and were about ready to pupate. In addition to the age factor, it is possible that

they were forced into pupation due to the unnatural ecological conditions which prevailed in the cages containing the potted plants.

The larvae of Lema trilineata (Oliv.) were at or near the base of the plant in the soil. The pupal cells were about one inch below the surface of the soil. It is not known whether this is the depth at which they would pupate in the field but they could have pupated in the pots at any depth up to a maximum of eight inches. The pupal case was enclosed in a small cell of whitish material which resembled a mixture of silk and small particles of soil. The cells were oval in shape, and while many were placed in a vertical position, some were horizontal. When the adults emerged from the cells, they did not always emerge from the end toward the surface of the ground. There was no consistency as to which end of the cell from which the adult will emerge. The end from which the adults emerged was cut out in a circle. Thirty adults emerged from 30 pupal cases. Ten of the adults were placed in the ground cherry insect collection, and the other 20 were used in other rearing studies, which were later discontinued.

Rearing Records of Heliothis virescens (Fabr.). During the collection of pods for examination in the summer of 1946, four larvae were removed from the inside of the husk. These larvae were feeding on the berry, but were causing no damage to the husk in the field. The four larvae were caged in the laboratory, and berries enclosed in the husk were placed in the cages for them to feed upon. In every instance, the berry was

eaten first, and when it was gone, they would eat the husk. Although it was evident from observations in the field and in the laboratory that the larvae preferred the berry, they would eat the husk if nothing else was available, and apparently thrived on it. Fresh food was made available at least once a day for them, and in nine days they pupated. Upon emergence, they were identified as Heliothis virescens (Fabr.), formerly called Chloridea virescens (Fabr.), the true budworm. None of these larvae was ever found feeding on the leaves of ground cherry plants, but was always inside the husk, feeding on the berry itself.

Record of Nathalis iole Bdv. On August 5, while collecting insects from ground cherry near the insectary, a small chrysalis was found hanging to one of the stem branches of a ground cherry plant, Physalis subglabrata M. and B. The chrysalis was brought into the insectary and placed in a glass jar covered with a fine mesh wire. On August 7, the adult emerged. It was later identified as Nathalis iole Bdv., the smallest species belonging to the family Pieridae known to occur in Kansas. It is normally a feeder on the leaves of clover and alfalfa. Only one specimen was taken during the two summers which the problem covers, and as has been indicated, it was found in the pupal stage, so no observations as to whether it fed upon ground cherry or not were possible.

Tomato Hornworms - Phlegethontius quinquemaculatus (Haw.). One tomato hornworm was taken feeding on ground cherry on July 29, 1946. The larva was brought into the laboratory where it

Table 1. Insect damage to fruit of ground cherry - 1947.

Date	Location (Area)	Husk damaged		Husk undamaged		Total
		Berry undamaged	Berry damaged	Berry undamaged	Berry damaged	
July 30	1	60	141	218	326	745
August 2	2	89	121	125	71	406
August 7	3	10	38	66	156	270
August 9	4	46	13	16	1	76
August 13	5	104	161	104	90	459
August 16	6	64	305	76	119	464
August 18	7	51	33	139	49	272
August 20	8	90	38	59	12	199
August 23	9	54	149	39	49	291
August 24	10	63	342	84	173	662
August 25	11	371	344	71	40	826
August 27	12	139	320	360	371	1190
Totals		1141	1905	1357	1457	5860
Percentage		19	33	23	25	100

fed on leaves of Physalis sub-labrata M. and B. for three days. It died August 1 without having pupated. While it was alive, it appeared to feed on leaves of Physalis sub-labrata M. and B. just as well as it did on leaves of tomato. From descriptions and pictures of larvae, it is believed that it was the larva of Phlegethontius quinquemaculatus (Haw.) called the tomato hornworm by some, and the tobacco hornworm by others.

Rearing Records of Evippe leuconota Zellers. During the summers of 1946 and 1947, pods of ground cherry which showed external evidence of damage were collected. These pods were placed in seamless one ounce salve boxes. It was from these damaged pods that the adults of Evippe leuconota Zellers, emerged.

During the months of July and August, 1946, damaged pods of ground cherry were brought into the laboratory almost every day and placed in salve boxes, one pod in a box. It was during the latter part of August that adults of Evippe leuconota Zellers were found most numerous in the salve boxes.

In two full summers of observing and collecting, no specimens of Evippe leuconota Zellers were taken from ground cherry plants in the field. Every specimen in the collection has been obtained by rearings from damaged pods. Attempts to locate adults in the field were unsuccessful. No specimens were obtained during the sweeping studies made in September, 1947.

During August and September of 1947, over 5,000 berries of ground cherry were split open with a razor blade. Larvae believed to be those of Evippe leuconota Zellers were abundant.

The larvae were present in all stages of development of the berries examined. They were found in berries scarcely larger than a pea and they were found in berries which were nearly fully matured. The presence of larvae in the small berries indicates that the eggs are deposited very early in the development of the berry. After the berries were opened, no larva continued with its development. Even in those instances when the insect was in the pupal stage, development stopped. During this same period, ground cherries were swept for the collection of insects, but no adults of Evippe leuconota Zellers were found.

This small lepidopterous species, Evippe leuconota Zellers, is probably the most destructive insect pest of ground cherry. So far as could be learned from studies here, it was the only insect which feeds in the seed pod of ground cherry. Destruction of the seed pod is especially important since it greatly reduces the number of plants propagated by natural seeding. Since the mosaic diseases of tobacco and cucumbers overwinter in the roots of ground cherry, and since Evippe leuconota Zellers is an important insect pest of ground cherry, it could be considered a beneficial insect.

Rearing Records of Estigmene acraea Drury. During the last week of July, 1947, four rather large, yellowish, woolly larvae were collected from Physalis subglabrata M. and B. The larvae were feeding on the leaves and tender tips of the stem. The larvae were brought into the laboratory and placed in pint fruit jars which had about four inches of soil on the bottom.

The larvae were fed with leaves and small stems of Physalis subglabrata M. and B. and Physalis virginiana Mill. The larvae were collected on July 1, they pupated on July 6, and on August 6, the adults emerged. The pupal cells were in the soil at a depth of about one inch. This is probably the normal depth since they could have gone deeper. The remnants of several leaves upon which the larvae had been feeding were used to cover the top of the pupal cell. The leaves were resting on the surface of the soil, next was the outer shell of the cell, a dense mat of woolly hairs and fibers, and inside this mat of hairs and fibers was the pupa. The pupal period was 31 days, and upon emergence the moths were identified as being Arctiids, Estigmene acraea Drury, one male and one female. Later two others emerged, making four in all. The last two were females. At Manhattan, the larvae were found at two different locations: at the Agronomy Farm one mile north of town, and south of town about four miles, along the Kansas River. At both places, the larvae were eating the leaves from the stems of the plants, leaving them without a single leaf. In some cases, the tender tips of the branches, smaller subbranches, and leaves had been eaten.

Aphids. During the two summers included in this report, no specimens of aphids were taken from ground cherry plants. Three species of aphids have been reported previously on ground cherry. All three species of aphids mentioned in the literature have been taken in Kansas.

Recovery of Ground Cherry Plants from Injuries. Leaf

damage to ground cherry plants appeared rather unimportant with regard to the future health of the plant. This was true for the seven plants included in this study, which are all perennials. This condition may not be true of annual species. It was observed that it was possible for the perennial ground cherry to lose most of its leaves at least twice without causing serious damage. At the Agronomy Farm, plants were observed growing after having been cut off with a mowing machine. In these instances, new stems were sent up from the root stock just above the ground level. Plants cut back in June at Manhattan produced new stems and came into full fruit before the first killing frost. During the last part of August, 1947, one field in which ground cherries were growing was cut with a mowing machine. About two weeks later, the field was plowed and harrowed. The last week of September, green shoots of ground cherry were observed showing about three inches above the surface of the soil. With these examples of the hardiness of the plant in mind, it would seem to indicate that a considerable amount of leaf feeding on one plant would be necessary before that plant would be permanently and seriously injured. It is doubtful whether any except the largest of the lepidopterous larvae are capable of inflicting much damage. None of the plants under observation during the past two summers has shown an indication to die from the effects of leaf feeders.

Pod Examination. On July 30, 1947, the first attempt was made to find the percent of ground cherry plant fruit damaged

by insects. The method used in collecting fruits has been described in detail under the heading Pod Examination in Materials and Methods. Each plant was stripped of all mature fruit, and there was no discrimination of plants. The removal of the pods on the plants in each locality was not interrupted until all the pods were collected or until the collecting container was filled. The tabulation of these data is recorded in Table 1. The local areas included in the pod examination have been described under the section Materials and Methods.

Results of the Pod Examination. One of the outstanding facts revealed during the pod examination is the percentage of fruits with undamaged husks but with damaged berries. Of the 48 percent of fruits with undamaged husks, 25 percent have a damaged berry. From this, it appears that the husk is not the desirable portion of the fruit to insects. These figures also indicate that an examination of the husk alone on a plant would give no indication as to the condition of the berry inside the husk. This fact is of importance to growers of Physalis peruviana L., the cape gooseberry in Australia and South Africa, and of Physalis ixocarpa Brotero, the tomatillo in Mexico and southwestern United States. Both of these species are commercial crops, and it may easily be seen that a grower, in order to estimate the amount of damage to his crop, must remove the husk and look for damage in the berry. Even an examination of the berry itself would not be accurate unless the berries were opened. In many instances, it has been found that damage to the inside of the berry is not visible from the outside

until the damage is well advanced.

It may be interesting to note that while husk damage averaged 52 percent, the damage to the berry itself was 33 percent. In other words, 19 percent of the pods having damaged husks will produce normal fruit. This would further indicate that husk damage or freedom from damage is no indication as to the condition of the berry. From these figures, it became evident that while superficial examination of the husk showed damage to the husk, it did not indicate whether the berry was damaged.

Site and Extent of Pod Damage. When the pods of ground cherry were damaged sufficiently to be visible from the outside, the damage was found to occur most likely in one of two places. The most common visible damage was located at the base of the berry on the gynophore, which separates the berry from the base of the calyx. The damage consists of a hole in the gynophore. This hole was always made directly into the berry, and was usually more pronounced when the insect inside had pupated. This hole averaged about two mm. in diameter. The hole through to the outside of the berry was made just prior to pupation of the larva. As long as the insect was still in the larval state, the hole was open without a covering. However, just before the larva pupated, it spun a silken covering for the opening, sealing it off. During the examination of more than five thousand berries, it was found that the preceding statement was true in most instances. In this type of injury, the entire inside of the berry was eaten away, leaving

only a thin shell. The berry usually appeared elongated so that the diameter of the berry was not much greater than the diameter of the gynophore. In addition to the elongated appearance, the gynophore became wrinkled longitudinally and frequently the berry turned from a fresh green appearance to a greenish yellow. This type of injury usually occurred before the berry matured and, of course, prevented further growth of the fruit.

The other common type of injury to the berry usually occurred on the full rounded part of the berry. The damage was visible in an external examination due to a small hole which is usually present. The hole is about one mm. in diameter. It is characterized by having a very narrow ring of brown color around the hole. It has been noted that when this type of damage occurs, the inside of the berry was seldom entirely eaten as in the preceding type of injury. In damage of this sort, the seed producing ability is lowered to about 50 percent or slightly less, whereas, in the former type, no seed is produced. This hole in the berry was never covered with a silken material regardless of the stage of development of the insect.

While examining pods for damage, it was noted that in some cases even when there was no visible opening in the berry, damage could be detected. In these instances, certain areas of the fruit would appear hyaline. Instead of the usual uniformly green color throughout, little areas, usually quite irregular in outline, appeared light yellowish or whitish in

color, making the outer shell appear transparent. The berry in these instances was soft and pliable to the touch. The berry was not deformed in any way, as far as external appearance was concerned. It appeared perfectly normal. The berry was not wrinkled or sunken at any point. When opened, an almost mature larva was always found. This type of injury, as well as the two previously mentioned, had been observed when the husk was damaged and when the husk was undamaged. Both this and the former type of injury is caused by larvae of Evippe leuconota Zellers.

List of Insects Compiled from the Literature. The following list of insects includes only those insects which have been mentioned in the literature as being taken on ground cherry, Physalis Spp. Many have already been mentioned in the content of this thesis under the heading Review of Literature, but the writer felt that a list such as this would better serve to emphasize the species previously recorded on the plants in question, and to associate the insects with the proper orders and families to which they belong.

Coleoptera

Cassidinae	Deloyla clavata (Fabr.), (Glick-1922).
Curculionidae	Trichobaris trinotata (Say), Faville and Parrott-1899).
Chrysomelidae	Acalymma vittata (Fabr.), (Doolittle-1924).
	Leptinotarsus decimlineata (Say), (Daniels-1941).

	Lema trilineata Germ., (Union S. Africa Dept.-1920).
	Lema trilineata (Oliv.), (Marcovitch-1916).
	Epitrix cucumeris Harris, (Swenk-1940).
	Epitrix parvula Fabr., (Morgan-1924).
	Epitrix fuscata Duv., (Wolcott-1916).
	Systena basalis Duv., (Wolcott-1916).
Coccinellidae	Epilachna dodecastigma Muls., (Den Doop-1919).
Homoptera	
Aphididae	Aphis gossypii Glover, (Doolittle-1924).
	Macrosiphum rei Koch., (Hottes and Frison-1931).
	Macrosiphum solani Koch, (Patch-1925).
	Macrosiphum solanifolii Ash, (Webster-1915).
	Myzus circulflexus Buckt., (Patch-1925).
	Myzus persicae (Sulzer), De Jong-1929).
Psyllidae	Paratrioza cockerelli (Sulc.), (Daniels-1941).
Hymenoptera	
Chalcididae	Emersonella lemae Gir., (Chittenden-1924).
Lepidoptera	
Pyralididae	Leucinodes orbonalis Gn., (Union S. Africa Dept.-1922).
Gelichiidae	Phthorimaea operculella Z., (Newman-1922).

Noctuidae	Heliothis obsoleta (Fabr.), (Ballard-1924).
	Heliothis virescens (Fabr.), (Chamberlain-1926).
Arctiidae	Estigmene acraea Drury, (Morrill-1914).

Hemiptera

Lygaeidae	Lygaeus hospes F., (Hoffman-1932).
	Ischnus sordidus F., (Hoffman-1932).
	Acanthocoris scabrator F., (Hoffman-1928).

Diptera

Aleyrodidae	Bemisia gossypiperda Misra, (Misra-1929).

Insects Collected from Ground Cherry at Manhattan, Kansas.

The following list of insects includes only those species which were collected by the writer on ground cherry in and around Manhattan, Kansas, during the summers of 1946 and 1947. Several of the species in this list may be found in the list which was compiled from the literature. They have been included in both lists in order that each list may be complete in itself and in order to emphasize the fact that they have been observed on ground cherry by others. It is not to be supposed that this list is by any means complete. Neither is it to be supposed that all the insects on this list are closely associated with ground cherry. Many of the specimens were taken in sweepings, and while it is believed that all insects mentioned here were actually on ground cherry plants, since

precautions were taken so that only ground cherry plants were swept. However, some of the species may have been using the plants as a temporary resting place. Those insects which were actually observed feeding will be discussed following the listing of the species.

Coleoptera

Curculionidae	*Trichobaris trinotata* (Say).
	Lixpera punctata (Fabr.).
	Smicronyx casoyi Blatch.
	Desmoris scapalis Lec.
Chrysomelidae	*Lema trilineata* (Oliv.).
	Lema longipennis Linell.
	Diabrotica 12 punctata (Fabr.).
	Diabrotica longicornis (Say).
	Diabrotica atripennis Say.
	Disonycha triangularis Say.
	Disonycha alternata (Ill.).
	Typophorus viridicyaneus (Crotch.).
	Myochrous denticollis (Say).
	Cryptocephalus venustus Fabr.
	Metriona bicolor (Fabr.).
	Psylliodes punctulata Melsh.
	Haltica aenoscans Blatch.
Coccinellidae	*Certomegilla fuscilabrus* Muls.
	Hippodamia convergens Guer.
	Coccinella sanguinea Linn.

	Cyclonedia [illegible] (Say).
Melyridae	Collops quadrimaculatus Fabr.
Anthicidae	Notoxus monodon Fabr.
Meloidae	Zonites rufa Lec.
	Epicauta pennsylvanica DeG.
	Macrobasis segmentata Say.
Cleridae	Hydnocera pubescens Lec.
Lampyridae	Photinus pyralis Linn.
	Lucidata punctata Lec.
Elateridae	Monocrepidus bellus Say.
Cantharidae	Ditemnus latibolus Blatch.

Neuroptera

Chrysopidae	Chrysopa pleurobunda Fitch.

Homoptera

Membracidae	Ceresa bubalis Fabr.
	Microtalis calva Say.
	Stictocephalis inermis Fabr.
	Campylenchia latipes Say.
Fulgoridae	Acanalonia bivittata (Say).
	Oliarus aridus Ball.
Cicadellidae	Draeculocephala mollipes (Say).
	Cicadella hieroglyphica Ball.
	Cicadella hieroglyphica dolobrata (Ball).
	Helochara communis Fh.
	Xerophloea viridus (Fabr.).

[illegible] luoratus (Say).

Polyxenia fulvica (Say).

Lygus obscurinervis (Stal.).

Noxellina chenopodii (Osl.).

Empoasca Sp.

Hymenoptera

Braconidae — Bracon vulgaris (Cress.).

Bigelphus curculionis (Fitch.).

Lepidoptera

Noctuidae — Heliothis virescens (Fabr.).

Arctiidae — Estigmene acraea Drury.

Pieridae — Nathalis iole Bdv.

Gelechiidae — Evippe leuconota Zellers.

Hemiptera

Miridae — Adelphocoris rapidus (Say).

Adelphocoris lineolatus (Goeze).

Lygus pratensis oblineatus (Say).

Lygus pratensis strigulatus Walk.

Polymerus basalis (Reuter).

Cydnidae — Galgupha atra Amyot and Serville.

Sehirus cinctus (Palisot de Beauvois).

Lygaeidae — Lygaeus kalmii Stal.

Blissus leucopterus (Say).

Geocoris bullatus (Say).

	Geocoris bullatus floridanus Blatch.
Reduviidae	Sinea diadema (Fabr.).
Pentatomidae	Podisus maculiventris (Say).
	Thyanta custator (Fabr.).
	Peribalus limbolaris Stal.
	Euschistus variolarius (Palisot de Beauvois).
Neididae	Jalysus spinosus (Say).
Nabidae	Nabis ferus (Linn.).
Corizidae	Corizus hyalinus (Fabr.).
	Harmostes reflexulus (Say).

Insects Observed Feeding. Both larvae and adults of Lema trilineata (Oliv.) have been observed feeding on ground cherry. Adults have been taken from Physalis virginiana Mill., Physalis subglabrata M. and B. and Physalis longifolia Nutt. The larvae have been observed feeding on Physalis virginiana Mill. and Physalis subglabrata M. and B. The larvae are voracious feeders on leaves and tender tips of stems. The adults and larvae have been observed as early as June 8, and adults have been taken as late as September 11. The larvae were most abundant during the last week of June and the first three weeks of July. Adults were most numerous during the first part of June and again during the month of August.

Only the adults of Diabrotica 12 punctata (Fabr.) have been found on ground cherry plants. Few were observed early in the summer. This species was most abundant during the month of August and the first two weeks of September when the sweep-

ing method of collecting was used. The adults were observed feeding on Physalis virginiana Mill., Physalis subglabrata M. and B. and Physalis longifolia Nutt. They were feeding on the leaves.

The larvae of the Heliothis virescens (Fabr.) were found feeding in the pods of ground cherry. In all instances, the larvae were inside the husks feeding on the berries, and in no case in the field was injury found to the husks of the berries upon which the larvae were feeding. In the laboratory, the larvae first consumed the berry and then, if there were no other berries available, they would eat the husk. Their feeding on the berries usually resulted in 100 percent destruction of the seed in those pods. The larvae were taken from pods of Physalis virginiana Mill., Physalis subglabrata M. and B., Physalis longifolia Nutt. and Physalis macrophysa Rydb. No adults were taken from or around ground cherry plants.

The larvae of Estigmene acraea Drury, (Lepidoptera), have been observed feeding on ground cherry. The larvae were feeding on the leaves of the plants, and after completely defoliating the plant, they ate back an inch or more on the tips of the stems. The larvae were taken from Physalis virginiana Mill., but were never found in abundance. Only four larvae were found during the summers of 1946 and 1947.

Larvae, pupae and adults of Trichoberis trinotata (Say) have been found in the stems and roots of ground cherry. The results of this study have been fully recorded under Stem Examination for Trichoberis trinotata (Say) in Presentation

and Discussion of Data, so will not be discussed at this point.

The adults of Nabis ferus (Linn.) and Sinea diadema (Fabr.) have been observed and collected from ground cherry. Both insects are predacious, feeding on smaller and slower insects. These insects were never observed actually feeding, but Nabis ferus (Linn.) was most abundant during the last part of August and the early part of September, a time when leaf-hoppers were prevalent. Sinea diadema (Fabr.) was taken on Physalis virginiana Mill. Nabis ferus (Linn.) has been taken on Physalis longifolia Nutt., Physalis virginiana Mill. and Physalis subglabrata M. and B. Nabis ferus (Linn.) was most abundant in patches which were made up of Physalis virginiana Mill. and Physalis longifolia Nutt. It was taken only by sweeping ground cherry.

Adults of the Microtalis calva Say have been taken on ground cherry. Two color variations, one with a black pronotum, and one with a yellowish-orange pronotum, have been taken. The most numerous have been those with the black pronotum. This species has been found on the leaves in but few cases. In nearly all instances, it was found along the stem branches, in the axil of a leaf, or at the junction of two branches. The adults are rather difficult to see in the axils of the leaves, where they are often mistaken for an axillary bud.

Stem Examination for Tricholaris trinotata (Say). The following table is a complete record of the examination of ground cherry stems for the potato stalk borer, Trichobaris trinotata (Say).

EXPLANATION OF PLATE II

Location of insect damage to ground cherry plants.

A. *Lema trilineata* (Oliv.).

Diabrotica 12 punctata (Fabr.).

Estigmene acraea Drury.

B. *Microtalis calva* Say.

C. *Trichobaris trinotata* (Say).

D. *Evippe leuconota* Zellers.

Heliothis virescens (Fabr.)

PLATE II

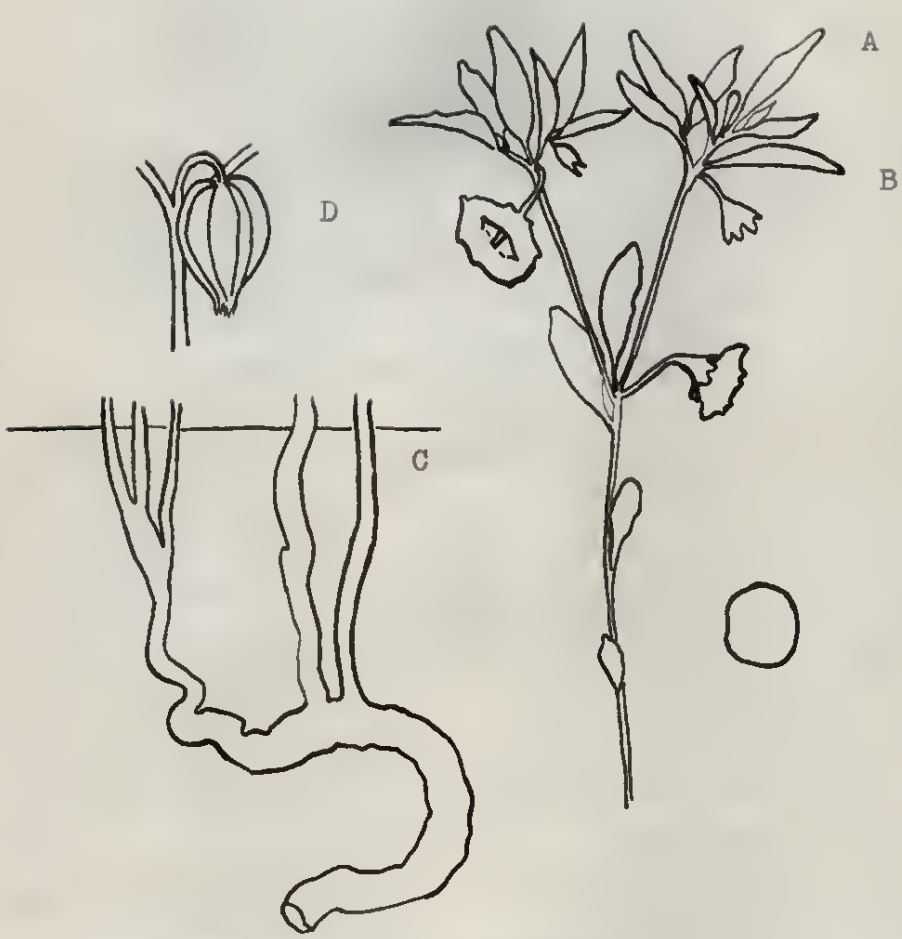

Table 2. Results of stem examinations for Trichobaris trinotata (Say).

Date	Area	Adults[1]	Pupae[2]	Larvae	Uninfested	Total
October 1	1, 12	28	15	2	96	141
October 4	11	11	0	0	20	31
October 6	5	46	6	4	106	162
Totals		85	21	6	222	354
Percentages		25	6	2	67	100

[1]October 1, 1947: One stem had two pupae.
[2]Two stems had two adults.

October 1, 1947: One stem had a hymenopterous parasite.

October 4, 1947: One stem had one adult and one pupa.

October 6, 1947: Three stems had two adults.

Adults of Trichobaris trinotata (Say) were taken on ground cherry plants in June. At that time the beetles were on the upper stem branches. By the middle of June, no adults were seen on any of the plants examined. No adults were found during the last week of August and the first week of September when sweeping of ground cherry was done. As may be seen from the table, 33 percent of the plants examined were infested. Three stages of the insect were found, adult, larva and pupa. Eight plants examined had more than one insect in the stalk.

When the stems were split open, a narrow, brown line was visible for several inches above the main tunnel which indicated that the larva had started in the upper part of the stem and

EXPLANATION OF PLATE III

Fig. 1. Adults and larva of *Trichobaris trinotata* (Say).

Fig. 2. Larva of *Trichobaris trinotata* (Say) in stem of ground cherry.

PLATE III

Fig. 1.

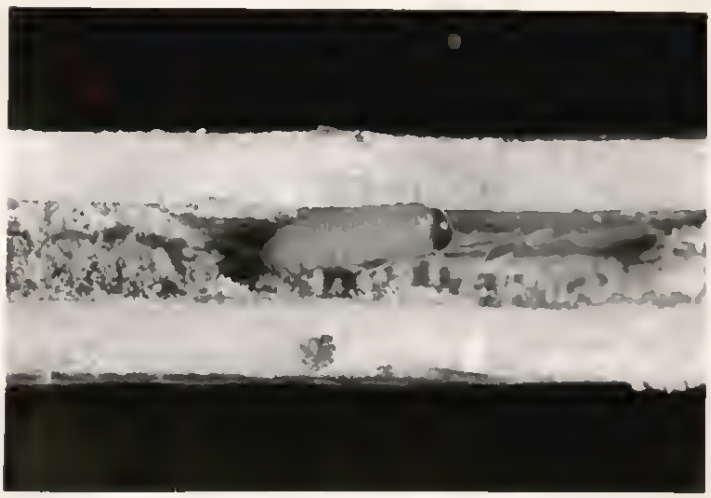

Fig. 2.

worked toward the ground level. From about six inches above to about three inches below the surface of the soil, the pith was destroyed in the stem. Although the main tunnel penetrated into the root, the insects were never found that far down. They were always from one to two inches above the lower end of the tunnel, separated from the end by at least one plug of frass in the tunnel. Usually the pupae were located one or two inches below the surface of the soil, with two partitions of frass separating them from the end of the tunnel. There were also plugs between the pupal case and the surface of the soil. In most instances, there was a small space between the two plugs. The point from which the adult would emerge was plainly visible when the stem was split. About one inch above the ground level, a secondary tunnel leads off toward the outside of the stem. This tunnel never actually opened to the outside, but usually left the bark to be penetrated by the emerging adult. Since both larvae and pupae were found in the stems so late in the season, it is quite likely that the insect overwinters in the stem either as an adult or as a pupa. Adults have been found in the stem after a severe frost in the fall.

During the stem examination for infestation by Trichobaris trinotata (Say), only one specimen of the hymenopterous parasite, Sigalphus curculionus (Fitch.) was found. The parasite found was an adult, fully winged, living in the cell which normally would be the overwintering habitat of a pupa or an adult of Trichobaris trinotata (Say). The cell was

complete, the usual plugs were found both at the lower and upper ends of the cell, and the secondary tunnel through which the emerging adult leaves the stem was present. The skin of the trichobarid larva was present in the cell.

SUMMARY

Since most of the common ground cherry plants which occur in Kansas are perennials, the leaf feeding insects have little effect upon them since they are able to put out new leaves and even stems several times during the season. It has been noted that the perennials are able to withstand cutting back to the ground level at least twice during the course of a summer.

It has been found that the appearance of the husk around the berry is no indication as to the presence of an infestation of the berry inside. The husk may appear undamaged in instances where the berry has been completely destroyed and vice versa. It has also been found that even though the berry, to all external appearances is undamaged, upon opening is often found to be infested.

Some types of damage to the berry, such as late infestation by Evippe leuconota Zellers, does not entirely destroy the seed, but it does leave it unfit for consumption. Thus, if Evippe leuconota Zellers were to be used as a control measure for the wild species of ground cherry, it would have to be used in conjunction with some other control measures since it does not totally destroy the seed producing capacity of the

berry, and does not damage the plant.

It is known that the mosaic diseases of cucumber, tomato and tobacco overwinters in the root stalks of Physalis Spp., and is readily transmitted to these crops in the spring by Aphis gossypii Glover and Acalymma vittata (Fabr.).

CONCLUSIONS

It seems that for best farming practice, ground cherry plants should be eliminated wherever possible. Since they are the secondary and alternate food plants of such common insect pests of cultivated crops as Acalymma vittata (Fabr.), Leptinotarsus decimlineata (Say), Lema trilineata (Oliv.), Aphis gossypii Glover, Heliothis virescens (Fabr.), Diabrotica 12 punctata (Fabr.), elimination of the ground cherry would be a step toward control of these pests. Ground cherry is a perennial, and the leaves appear very early in the spring, in advance of related commercial crops such as potatoes, tomatoes and egg plants. It thus furnishes overwintering and early emerging adult insects with both a place to feed and to lay eggs.

Insect enemies of ground cherry are not effective as a means of controlling its spread or eliminating the plants. Many of the ground cherries are perennial and are able to resist serious defoliation.

It would appear from the species collected on ground cherry that these plants furnish a desirable hiding place for

many insects which could easily become a problem in cultivated crops.

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